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MAU-12 C/A ELECTROMAGNETIC IMPULSE EMISSION TEST

William H. Colyer

TECHNICAL REPORT NO. AFSWC-TR-71-51

AIR FORCE SPECIAL WEAPONS CENTER
Air Force Systems Command
Kirtland Air Force Base
New Mexico 87117

January 1972

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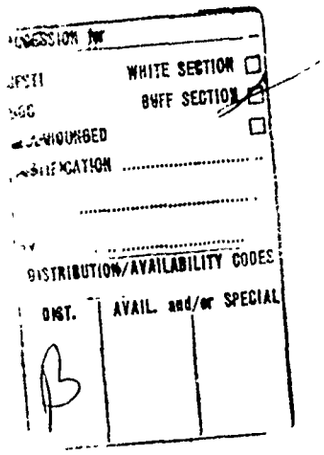

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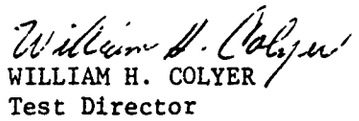
FOREWORD

This research was performed under Program Element 64202F, Project 5708, Task 03.

Inclusive dates of research were June 1971 through July 1971. The report was submitted 18 November 1971 by the Air Force Special Weapons Center Test Director, Mr. William H. Colyer (FTSE). The Air Force Weapons Laboratory Project Officer was Captain F. G. Hertzler (SEE).

This technical report has been reviewed and is approved.



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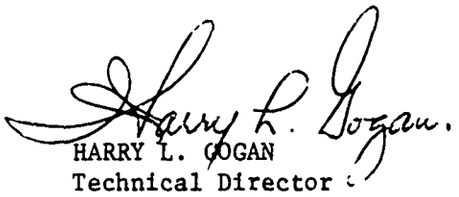

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ABSTRACT

(Distribution Limitation Statement B)

Electromagnetic impulse emissions generated by solenoids in the MAU-12 bomb rack at the instant of deenergization were thought to be excessive. Two MAU-12 bomb racks, one mounted in an F-111/E pylon, were used to determine the electromagnetic impulse voltages. The measured voltages far exceeded expectations.

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ILLUSTRATIONS

SECTION I

INTRODUCTION

1. PURPOSE

This test was part of the overall test program on the F-111/E pylon and MAU-12 bomb rack. The test was conducted to determine the degree of electromagnetic impulse (EMI) emission from the arming solenoids.

2. AUTHORITY

The authority for this investigation is contained in Universal Documentation System, Statement of Capability for Project 5708 entitled "Nuclear Weapon Support," dated 8 June 1971. The investigation was requested by Air Force Weapons Laboratory in a memorandum entitled, "AFSWC Test Support Requirements," dated 25 May 1971.

3. BACKGROUND

The MAU-12 bomb rack employs three arming solenoids: one located at each end of the rack and one mounted next to the breech assembly. The arming solenoids are used to either arm the weapon by retaining the arming wire at weapon release or for selecting fuzing options.

Electromagnetic impulse emissions generated by the solenoids at the instant of deenergization were thought to be excessive. The phenomenon producing this electrical pulse is the back electromagnetic force (EMF) generated by the breakdown of the magnetic field in the solenoid. The reverse pulse was thought to be detrimental to the nuclear safety of the aircraft. With increasing complexity and miniaturization of aircraft monitor and control systems, a stray pulse, if not properly isolated or eliminated, could have far reaching nuclear safety effects.

SECTION II

SUMMARY OF TESTS

1. TEST ITEM

The MAU-12 Bomb Ejection Rack (figure 1) is designed to carry either conventional or nuclear stores (weighing as much as the 5000-pound class stores) externally under a fighter-bomber. Two pairs of mutually coupled hooks allow for weapon lug spacing of either 14 or 30 inches. The payload can be forcibly ejected or allowed to fall free from the aircraft. The MAU-12 is compatible with a variety of store casings whose external diameter ranges from 10.7 inches to 33 inches. When forced ejection is used, the pistons that kick the weapon free of the aircraft retract into the rack, thus presenting a clean profile to the airstream. Another main feature of this bomb rack is the nuclear safety interlock, which must be actuated before the store can be released. The lock, which restricts movement of the rack hook linkage, is controlled by a solenoid approximately 2 inches in diameter by 2-1/2 inches long. The lock is designed in a manner so that when the solenoid is in the deenergized state, the rack is in the locked condition. Upon activation of the solenoid the restriction is removed from the rack linkage, placing the rack in the ready position. In conjunction with the lock are a pair of switches that isolates the cartridges from the fire signal when the rack is in the locked condition and completes the circuit to the cartridges when the rack is unlocked.

The MAU-12 bomb rack employs three arming solenoids: one located at each end of the rack and one mounted next to the breech assembly. The arming solenoids are used to either arm a weapon by retaining the arming wire at weapon release or for selecting fuzing options.

2. TEST REQUIREMENTS

a. General

The EMI pulse was to be monitored at the F-111/E pylon and also at the MAU-12 rack with an oscilloscope. Polaroid photographs were to be taken of all pulse traces. Measurements of pulse width and pulse peaks were to be determined from these photographs. The test configurations had been designed to energize all relays and solenoids.

b. MAU-12 Bomb Rack

The EMI pulse was to be monitored at the MAU-12 receptacle and at the cartridge breech for each of the following test conditions:

Test No.	Receptacle No.	+28 Volts Applied Momentarily	Monitor
1	(351P11)	Pin K -28v at S	Pin K and Cartridge Breech
2	(351P11)	Pin P -28v at R	Pin P and Cartridge Breech
3	(351P11)	Pin L -28v at M	Pin L and Cartridge Breech

c. F-111/E Pylon and MAU-12 Rack

The EMI pulse was to be monitored at the Armament and Control (AMAC) receptacle (J-609-1) and the cartridge breech. Each test, 4 through 15, was to include the following sequence of steps, (1), (2), (3), and (4), with the pylon grounded at receptacle P-6000-10, pins 6 and 7. Table I shows which relays were to be energized during each test, and at what point EMI voltage was to be measured. The procedures for activating the relays are shown in table II. Plus 28 volts DC were to be applied to receptacle P-600-10 and receptacle P-600-11, pin 1.

(1) Apply and release +28 volts DC to pin 16 on receptacle P-600-4. (Measure the EMI voltage.)

(2) Apply and release +28 volts DC to pin 17 on receptacle P-600-4. (Measure the EMI voltage.)

(3) Apply +28 volts DC to pins 8 and 21 on receptacle P-600-4, release +28 volts DC from pin 8 on receptacle P-600-4. (Measure the EMI voltage.)

(4) Apply +28 volts DC to pins 8 and 21 on P-600-4, release +28 volts DC from pin 21. (Measure the EMI voltage.)

3. TEST PROCEDURE AND RESULTS

a. MAU-12 Bomb Rack

An MAU-12 B/A rack was used for tests 1, 2, and 3. The voltages produced on the rack were obtained by activating a toggle switch through a relay on the F-111/E pylon. The test was conducted according to the test requirements. The output voltages were recorded on a Tektronix 565 oscilloscope and Polaroid photographs were obtained. The measured peak voltages for these tests are:

	Pin Monitor			Cartridge Breech Monitor		
Test	Peak Volts	Rise Time* (msec)	Pulse Duration** (msec)	Peak Volts	Rise Time (msec)	Pulse Duration (msec)
1	410	2.60	8.20	NA	NA	NA
2	520	0.48	0.90	5.20	0.17	0.88
3	55	2.20	5.50	2.20	0.22	0.55

*Rise time is the time from zero to maximum voltage on the initial voltage pulse.
**Pulse duration is the time for the initial voltage pulse to rise from zero and return to zero.

Typical oscilloscope records obtained during the test are shown in figures 2 and 3.

b. F-111/E Pylon and MAU Bomb Rack

An MAU-12 C/A rack mounted in an F-111/E pylon was used for tests 4 through 15. The MAU-12 B/A bomb racks and MAU-12 C/A racks are designed to be electrically identical. The test setup is shown in figure 4. Figure 5 shows the F-111/E pylon and MAU-12 C/A rack with the side panels removed to expose the electrical connections. The test was conducted according to the test requirements. The maximum measured voltages are shown in table III. Typical oscilliscope records obtained during the test are shown in figures 6 through 9.

SECTION III

CONCLUSIONS AND RECOMMENDATION

1. CONCLUSIONS

a. All test requirements were met.

b. The maximum peak voltage measured on the MAU-12 B/A rack was 550-volts DC with a total pulse duration of 5.5 milliseconds.

c. The maximum voltage measured on the MAU-12 C/A rack mounted in the F-111/E pylon was 85 volts with a total pulse duration of 124 microseconds.

2. RECOMMENDATION

Further investigations should be made to determine if EMI emissions of this magnitude are detrimental to the nuclear safety of the aircraft.

Figure 1. MAU-12 B/A Bomb Rack

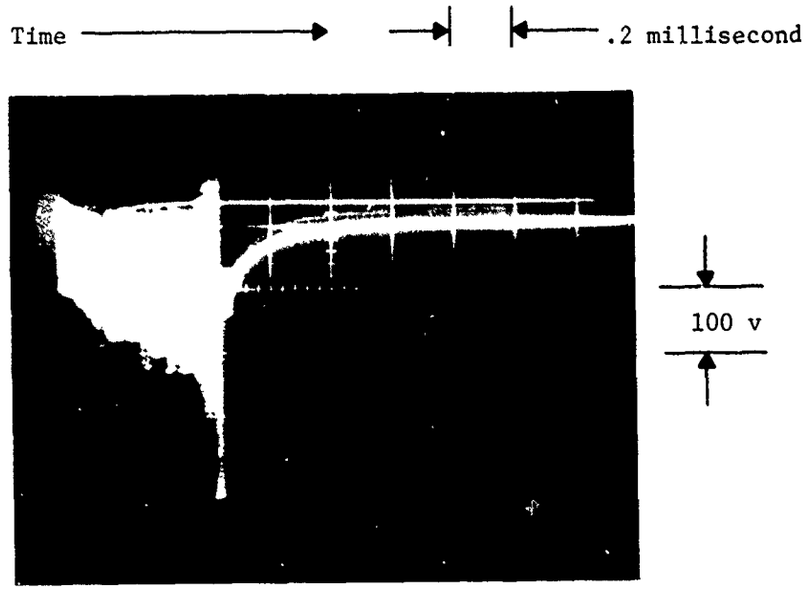

Figure 2. EMI Pulse Obtained During Test No. 2
Voltage Measured at Pin P

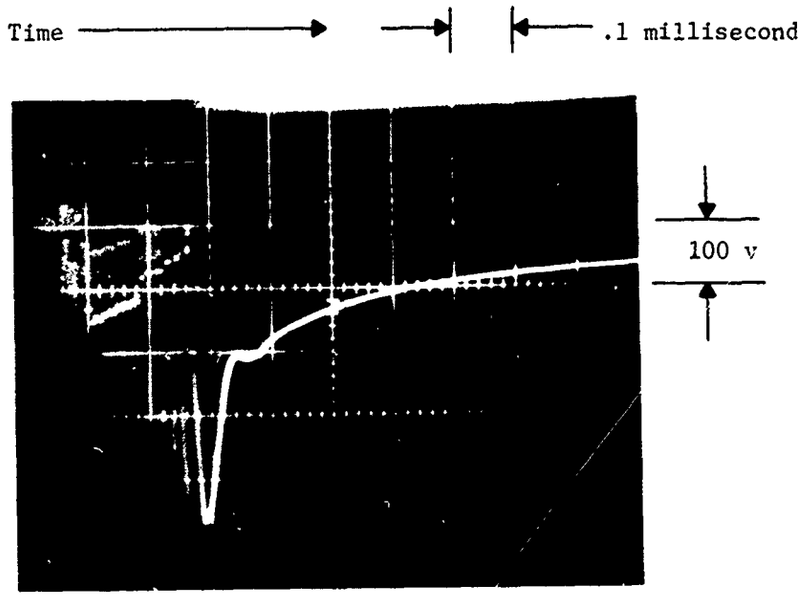

Figure 3. EMI Pulse Obtained During Test No. 3
Voltage Measured at Pin L

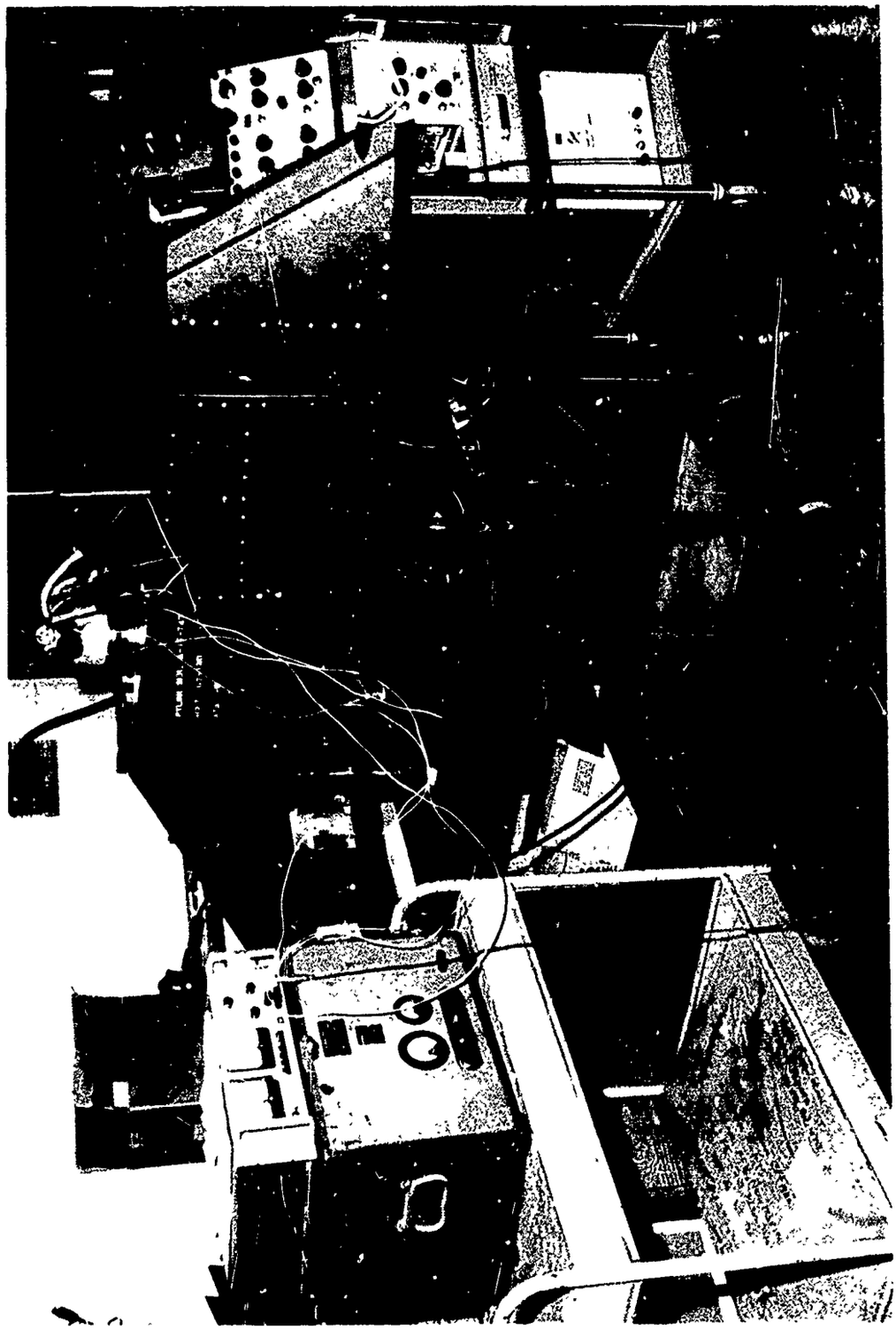

Figure 4. F-111/E Pylon--MAU-12 C/A Test Setup

Figure 5. F-111/E Pylon and MAU-12 C/A Rack with Panels Removed to Show Electrical Connections

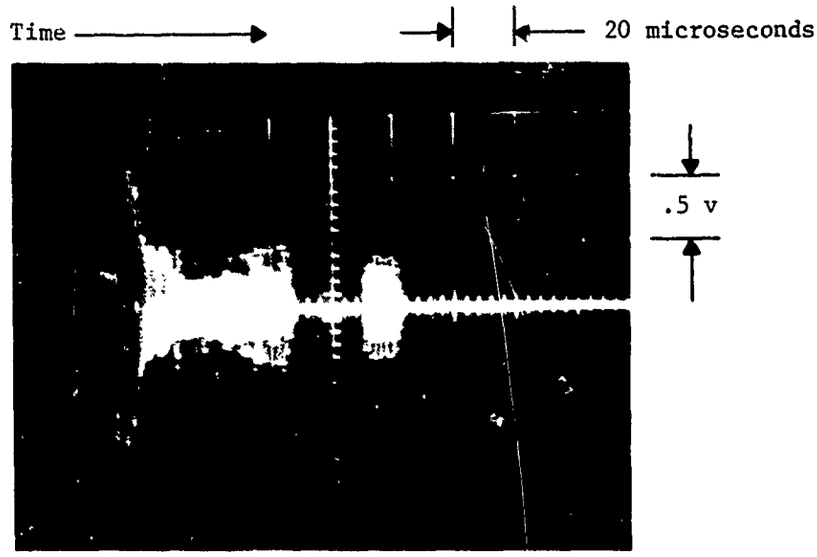

Figure 6. EMI Pulse Obtained During Test 4, Step 2

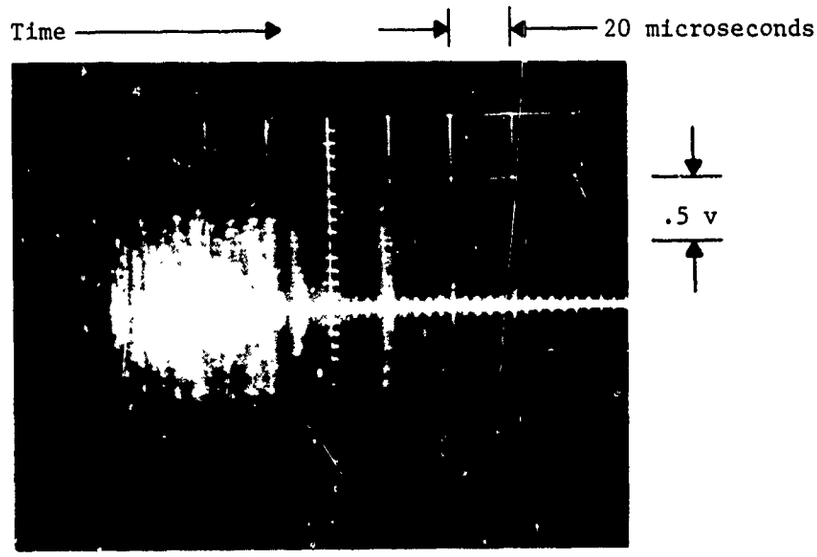

Figure 7. EMI Pulse Obtained During Test 4, Step 3

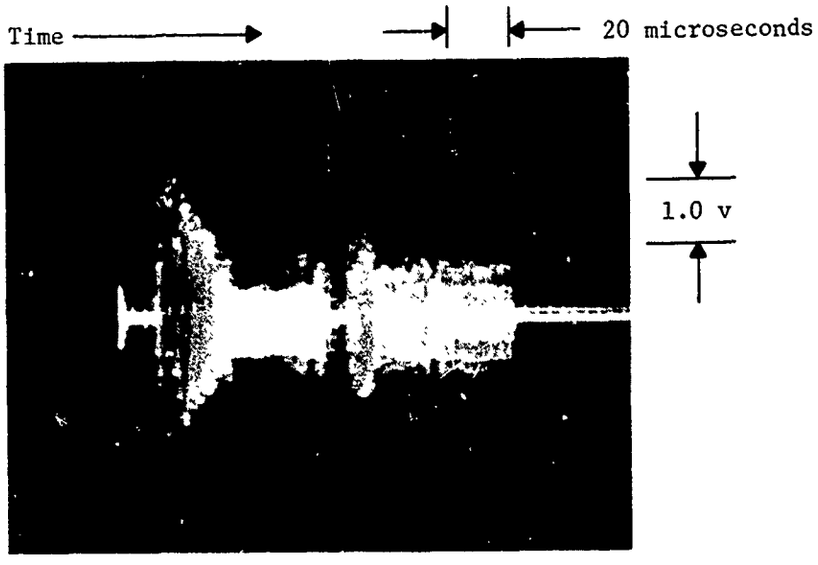

Figure 8. EMI Pulse Obtained During Test 13, Step

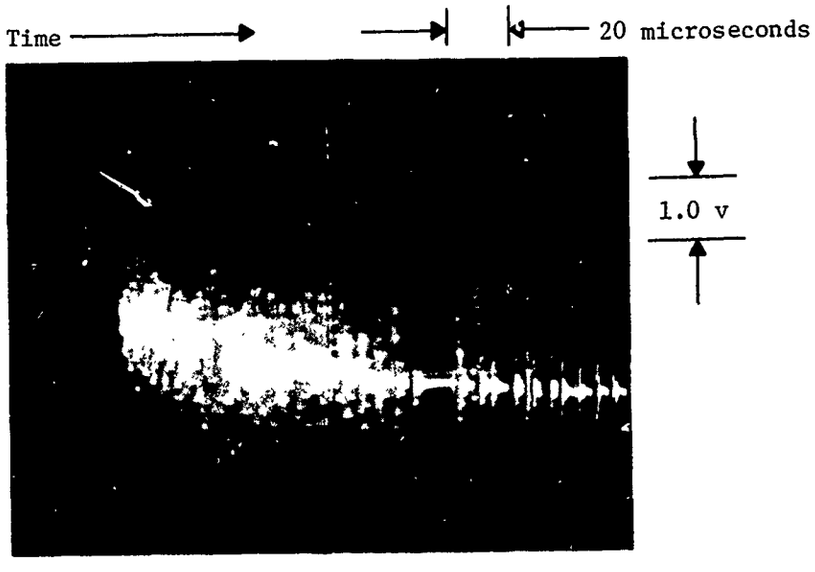

Figure 9. EMI Pulse Obtained During Test 13, Step 3

Table I

ENERGIZED RELAYS AND MONITORING POINTS

Test No.	Energized Relay	EMI Voltage Measured at
4	None	Cartridges
5	K8, K11	J-609-1 Receptacle Pin X
6	K8, K11	J-609-1 Receptacle Pin F
7	K8, K11, K14	J-609-1 Receptacle Pin D
8	K8, K11, K13	J-609-1 Receptacle Pin Z
9	K8, K10	J-609-1 Receptacle Pin E
10	K8, K10	J-609-1 Receptacle Pin J
11	K8, K10	J-609-1 Receptacle Pin H
12	K8, K10, K12	J-609-1 Receptacle Pin Y
13	K8	J-609-1 Receptacle Pin A
14	K6	J-609-1 Receptacle Pin A
15	K7	J-609-1 Receptacle Pin A

Table II

PROCEDURES FOR ACTIVATING RELAYS

Relay	Relay Activation
K6	P-600-9 Receptacle Pin 14, +28 volts
K7	P-600-9 Receptacle Pin 7, +28 volts & J-609-1 Pin B grounded
K8	P-600-9 Receptacle Pin 31 grounded
K10	P-600-9 Receptacle Pin 1 +28 volts
K11	P-600-9 Receptacle Pin 1 +28 volts
K12	P-600-9 Receptacle Pin 17 +28 volts
K13	P-600-9 Receptacle Pin 11 +28 volts (K11 must be deenergized before K13 actuation)
K14	P-600-9 Receptacle Pin 2 +28 volts

Reference T.O. 11B29-3-25-2 for wiring schematics.

Table III

TEST RESULTS OBTAINED DURING TESTS 4 THROUGH 15

	Step 1			Step 2			Step 3			Step 4		
Test	Peak Voltage	Rise* Time (μsec)	Pulse** Duration (μsec)	Peak Voltage	Rise Time (μsec)	Pulse Duration (μsec)	Peak Voltage	Rise Time (μsec)	Pulse Duration (μsec)	Peak Voltage	Rise Time (μsec)	Pulse Duration (μsec)
4	2.85	30	88	2.85	4	88	2.20	64	92	1.38	1	13
5	1.40	12	44	1.00	9	89	0.85	150	170	0.65	1	82
6	4.25	10	84	1.70	10	120	0.90	94	124	1.90	13	77
7	1.55	15	124	0.90	24	128	6.00	0.5	100	1.20	6	85
8	85.00	40	124	62.00	45	147	62.00	48	130	60.00	6	54
9	60.00	10	78	53.00	10	78	44.00	83	160	34.00	7	89
10	3.40	10	90	2.60	10	103	2.25	3	160	2.25	11	74
11	3.00	8	83	2.20	10	72	2.10	114	124	1.88	13	107
12	6.20	14	138	4.42	3	127	4.42	3	154	3.20	3	100
13	6.00	10	100	5.40	18	132	4.60	57	168	3.60	4	63
14	32.00	34	116	21.00	34	90	24.00	8	103	28.50	50	75
15	53.00	26	94	34.00	50	145	48.00	58	214	37.00	8	55

*Rise time is the time from zero to maximum voltage on the initial voltage pulse.
**Pulse duration is the time for the initial voltage pulse to rise from zero and return to zero.

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13. ABSTRACT

(Distribution Limitation Statement B)

Electromagnetic impulse emissions generated by solenoids in the MAU-12 bomb rack at the instant of deenergization were thought to be excessive. Two MAU-12 bomb racks, one mounted in an F-111/E pylon, were used to determine the electromagnetic impulse voltages. The measured voltages far exceeded expectations.

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